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Dune Sand Transport as Influenced by Direction, Magnitude and Frequency of the Erosive Winds, Ordos Plateau, China

L.Y. Liu, China Center of Desert Research, Beijing Normal University, Beijing 100875, China (E-mails: lianyou@public.lz.gs.cn; lianyou@weru.ksu.edu)
E. Skidmore, USDA-ARS, Wind Erosion Research Unit, Throckmorton Hall, Kansas State University, Manhattan, KS 66506, USA (skidmore@weru.ksu.edu)
L. Wagner, USDA-ARS, Wind Erosion Research Unit, Throckmorton Hall, Kansas State University, Manhattan, KS 66506, USA (wagner@weru.ksu.edu)
J. Tatarko, USDA-ARS, Wind Erosion Research Unit, Throckmorton Hall, Kansas State University, Manhattan, KS 66506, USA (jt@weru.ksu.edu)

Ordos Plateau is a region with extensive wind erosion, severe desertification and various aeolian sand hazards in China. In order to determine aeolian sand transport in this region, the relationship between sand transport rate and wind speed at 10min frequencies was established by field observation in both Qubqi Sand Desert and Mu Us Sandy Land. With an instantaneous spinning-cup anemometer, threshold wind speeds (2m above the ground) on mobile, semi-fixed and fixed dune surfaces were estimated in the field. Wind speeds at 0.5 and 2m heights above the ground were measured with standard spinning-cup anemometers. Synchronous with the wind speed measurement, sand transport in every 2-cm segment up to 40-cm height was measured by two step-like sand traps. High-resolution meteorological 10min average wind velocity data (10m above the ground) from the local weather stations were collected and converted to the height of 2m for calculation of sand transport potential. Aeolian sand quantity transported by the erosive winds was calculated for all speed levels in 16 directions, and annual quantities of sand transport on different dune surface types were determined by both vector operation and vector diagram techniques.

Threshold wind speed was 5-6 m s^{-1} on shifting dune and 6-8 m s^{-1} on semi-fixed and fixed dune surfaces. Sand transport rate increased radically with the increase of surface shifting mobility and near-bed wind speed. The sand transport rate on the shifting dune surface was higher by approximately an order of magnitude than the semi-fixed dune surface, and sand transport rate on the semi-fixed dune surface, in turn, was higher by an order of magnitude than the fixed dune. Three specific parameters - wind speed, blowing time and wind direction, were identified to be decisive for sand transport. The quantity of sand transport was affected directly by wind speed and duration, while the overall sand movement depended upon directions of the erosive winds. In the study area, erosive winds and aeolian sand transport mainly took place in springtime. The prevailing erosive wind directions were W, WNW and NW, with frequency of more than 60%, and sand transported in these three directions made up more than 70% of the total in all the 16 directions. The overall direction of sand transport was determined by the prevailing erosive winds with azimuth angles from 288.7 to 303.6°, indicating a general southeastward encroachment of aeolian sand. Wind frequency decreased as the negative power with the increasing wind speed. High magnitude strong winds had a low frequency, but they could play a dominant role in aeolian sand transport.